

# Wind Tunnel Tests Conducted to Develop an Icing Flight Simulator

As part of NASA's Aviation Safety Program goals to reduce aviation accidents due to icing, NASA Glenn Research Center is leading a flight simulator development activity to improve pilot training for the adverse flying characteristics due to icing. Developing flight simulators that incorporate the aerodynamic effects of icing will provide a critical element in pilot training programs by giving pilots a pre-exposure of icing-related hazards, such as ice-contaminated roll upset or tailplane stall. Integrating these effects into training flight simulators will provide an accurate representation of scenarios to develop pilot skills in unusual attitudes and loss-of-control events that may result from airframe icing.



*6.5-percent-scale Twin Otter model in the Wichita State University 7- by 10-ft wind tunnel for static testing.*

In order to achieve a high level of fidelity in the flight simulation, a series of wind tunnel tests have been conducted on a 6.5-percent-scale Twin Otter aircraft model. These wind tunnel tests were conducted at the Wichita State University 7- by 10-ft wind tunnel and Bihrl Applied Research's Large Amplitude Multiple Purpose Facility in Neuburg, Germany. The Twin Otter model was tested without ice (baseline), and with two ice configurations:

1. Ice on the horizontal tail only
2. Ice on the wing, horizontal tail, and vertical tail

These wind tunnel tests resulted in data bases of aerodynamic forces and moments as functions of angle of attack; sideslip; control surface deflections; forced oscillations in the pitch, roll, and yaw axes; and various rotational speeds. A limited amount of wing and tail surface pressure data were also measured for comparison with data taken at Wichita State and with flight data. The data bases from these tests will be the foundation for a PC-based Icing Flight Simulator to be delivered to Glenn in fiscal year 2001.



*Simulated ice shape on leading edge of the horizontal tail.*

Validation flight tests are planned to be conducted with the NASA Twin Otter Icing Research Aircraft equipped with similar artificial ice shapes in fiscal year 2001. Pilot training scenarios will be developed in cooperation with flight training experts, and the methodology of the development process documented in NASA technical reports.



*6.5-percent-scale Twin Otter model in Bihrlle Applied Research vertical wind tunnel for dynamic testing.*

**Find out more about icing research at Glenn (<http://icebox-esn.grc.nasa.gov/>).**

**Glenn contact:** Thomas P. Ratvasky, 216-433-3905, [Thomas.P.Ratvasky@grc.nasa.gov](mailto:Thomas.P.Ratvasky@grc.nasa.gov);  
and Thomas H. Bond, 216-433-3900, [Thomas.H.Bond@grc.nasa.gov](mailto:Thomas.H.Bond@grc.nasa.gov)

**Author:** Thomas P. Ratvasky

**Headquarters program office:** OAT

**Program/Projects:** AvSP (SWAP)